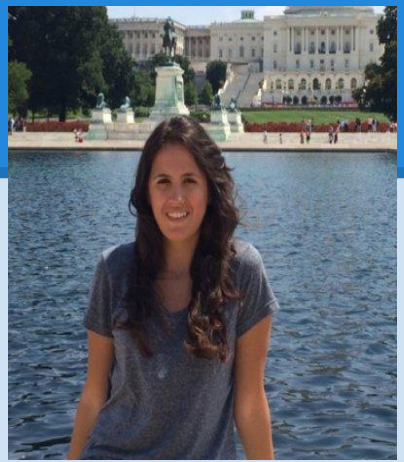
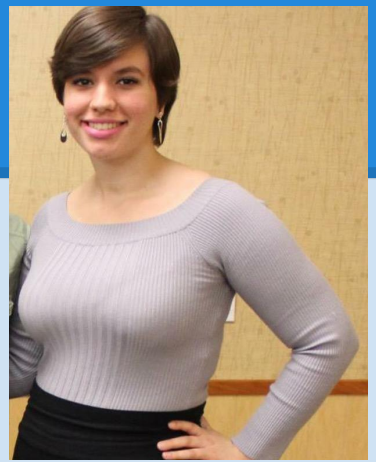
SDR - Spectrum Sensing

by Christina Baaklini, Michael Collins, and Nicole DiLeo





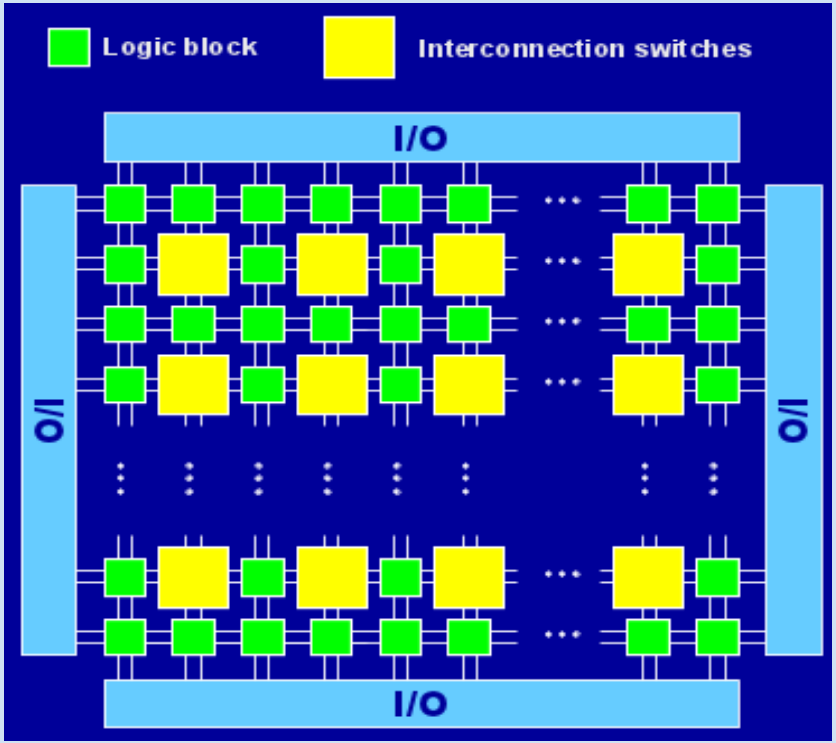
Overview

- **Introduction of FPGA**
- **Using OML to Gather IQ Samples**
- **MATLAB Spectrogram Script**

FPGA - Generic Structure

Field-Programmable Gate Array (FPGA) Building Blocks

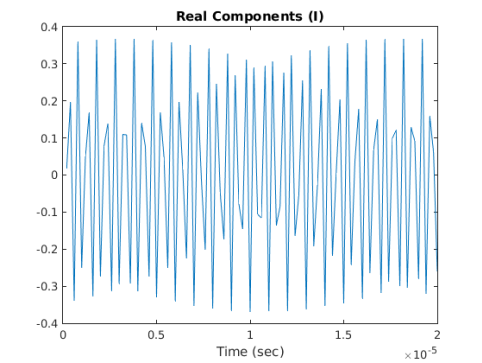
- Programmable Logic Blocks - Implement combinatorial and sequential logic
- Programmable Interconnect - Wires to connect inputs and outputs to logic blocks
- Programmable I/O Blocks - Special logic blocks at the periphery of device for external connections

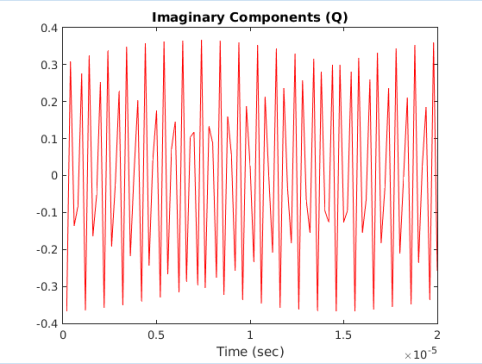


FPGAs are perfect for rapid prototyping of digital circuits

Source: Prasanthi M

Using OML to Gather IQ Samples



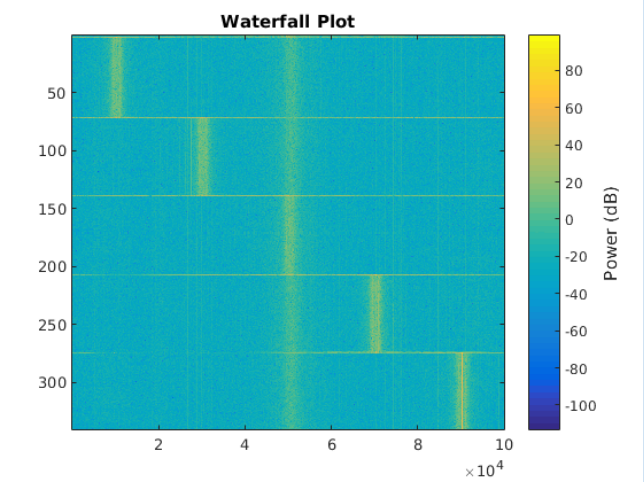


- **Previously used Fast-Fourier Transform data preprocessed by OML**
- **Can now use OML to gather raw IQ samples from a USRP receiver**
- **This gives us access to much larger and more precise data sets**
- **Provides more flexibility in processing the receiver readings**

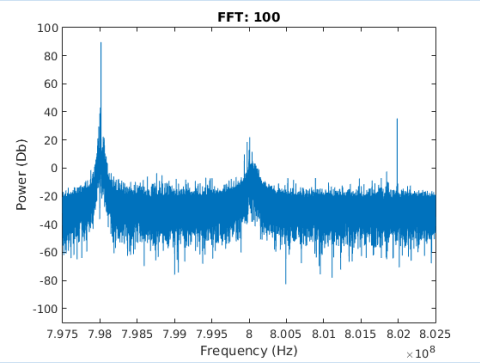
MATLAB Spectrogram Script

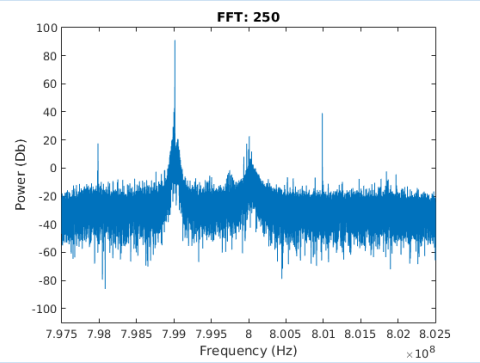
```
function n = spectro(m,c_fr,s_fr,k,o,w)
    % Create a spectrogram of the given time-domain signal
    % m =       row matrix of IQ samples
    % c_fr =    carrier frequency
    % s_fr =    sampling frequency
    % k =       size of FFTs
    % o =       overlap between FFTs (between 0 and 1)
    % w =       window function (row matrix of size k)

    o = 1-o; N = numel(m);

    start = @(j) k*o*j+1;        % beginning of each FFT
    stop = @(j) start(j)+k-1;    % end of each FFT

    n = []; i = 0;
    while stop(i) < N            % loop until last full FFT
        s = m(start(i):stop(i)); % extract IQ samples
        s2 = window.*s;          % apply the window function
        s2f = fft(s2,k);         % FFT
        s2f_shift = fftshift(s2f);       % adjust FFT
        n = [n;s2f_shift];       % append to output
        i = i+1;
    end

    Pnn = 10*log(abs(n));        % compute power readings

    figure; imagesc(Pnn);        % plot
    title('Waterfall Plot');
end
```

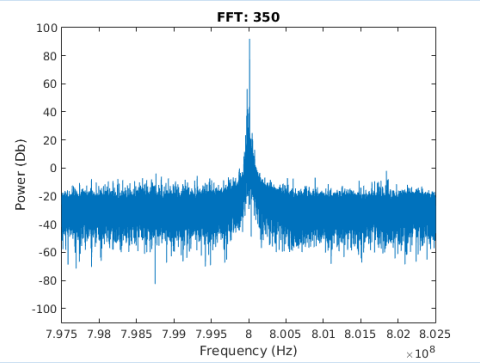
- **Transforms a time-domain signal into a frequency-domain signal and generates waterfall plot**
- **Used "readsamples" MATLAB function written by Dragoslav to read in binary files containing raw time samples from ORBIT USRPs**

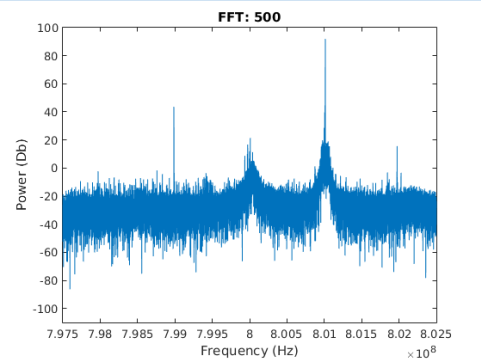


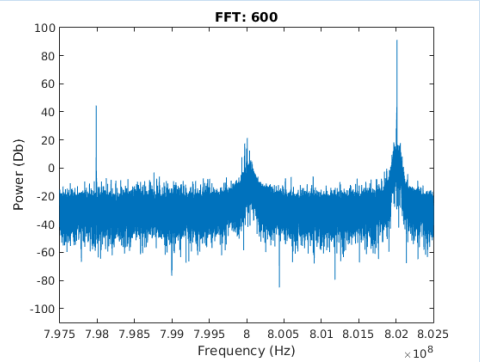
MATLAB Spectrogram Plot











Next Week

- **Write OEDL scripts that supports the interaction between more than one transmitter and respective receiver node**
- **Run tests on the grid using more than one transmitter and/or receiver**
- **Start filtering FFT samples**